

## THE OPERATIVE TREATMENT OF RECENT FRACTURES OF THE FEMORAL SHAFT.\*

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As a preliminary step in this undertaking, it seemed wise to determine as accurately as possible the range of discrepancy in the length of the lower extremities of normal adults.

It is generally believed that a difference of an inch or even more may exist in the measurement of normal limbs.

Accordingly fifty subjects were carefully measured for me by Mr. Sterling Bunnell, a senior student of the University of California, who submitted the following data:

The greatest discrepancy in any individual amounted to  $\frac{3}{4}$  of an inch (1.9 cm.).

Average discrepancy in 50 subjects proved to be slightly under  $\frac{1}{4}$  of an inch (.58 cm.).

Discrepancy exceeded  $\frac{1}{2}$  inch in 3 subjects (6 per cent.).

Discrepancy equal to .39 of an inch (1 cm.) in 10 subjects, 20 per cent.

Right leg longer than left 18, 36 per cent.; left leg longer than right 25, 50 per cent.; legs equal 7, 14 per cent.

Hence it appears that in dealing with thigh fractures discrepancy in length of normal limbs exceeding one-half inch is to be reckoned with in only six per cent. of all cases and that only in one per cent. of cases will the difference amount to  $\frac{3}{4}$  of an inch or more.

As a secondary step I formulated a circular letter embodying the following queries, which was sent to all members of the American Surgical Association and to other surgeons of this country and Canada:

1. What is your interpretation of the term "tolerable result" (i.e., satisfactory functional result) in fractures of the Shaft of the Femur?

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\* Read before the Medical Society of the State of California, April, 1908.

2. What degree of shortening is compatible with satisfactory function?
3. Is a definite amount of overriding of fragments permissible from the modern standpoint?
4. Are you satisfied with the average results attained by conservative (non-operative) treatment?
5. Are you an advocate of operative treatment as a routine initiative measure?
6. In operative procedure do you employ wire, nails, screws, staples or such an appliance as Parkhill's clamp?
7. Do you regard the danger of infection as contraindicating the operative treatment of simple fractures?
8. Has it been your habit to secure X-ray evidence of end-results on fractures of the femur?

Ninety-two answers were received. The data obtained from this source will appear elsewhere under appropriate headings.

The motive of this paper is:

1. To determine finally, if possible, what shall be regarded as a satisfactory end-result in fractures of the femoral shaft.
2. To ascertain whether or not anatomical replacement, and permanent fixation of fragments by operative interference is justifiable from the standpoint of infection and of improved end-results.

It cannot be denied that results of conservative treatment in thigh fractures have not, as a rule, conformed to the high ideals which govern every modern surgical undertaking.

During the past two decades surgical activities have centred closely upon abdominal and visceral lesions, while interest and enthusiasm seem to have waned as regards fracture treatment in general. As a rule surgeons of acknowledged skill and broad experience have approached ordinary thigh fractures with a jealously guarded prognosis, a faintly cloaked confession of inability to restore normal relation and function; and, at the end, in a certain proportion of cases adroitly framed apologies for manifest defects or deformities have been too often a forced expedient.

In 1890 the American Surgical Association appointed a committee to determine what should be considered a satisfactory result in simple fractures of the shaft of the femur.

The committee was composed of the following well-known gentlemen: Dr. Stephen Smith of the University of New York chairman, Drs. D. Hayes Agnew, David W. Cheever, D. W. Yandell, Charles T. Parkes, P. S. Conner, Charles B. de Nancrede and Hunter McGuire.

Smith's report submitted in 1891 was based upon opinions sent in by thirty-five members and was sanctioned by the Association. It embodied an analysis and discussion of all points involved by the question at issue.

His conclusions, slightly abbreviated, are as follows:

A satisfactory result may be predicated when:

1. Firm bony union exists.
2. Correct axial relations are maintained.
3. Preservation of correct relations of the anterior planes of upper and lower fragments.
4. Shortening not to exceed one-eighth to one inch.
5. Lameness, if present, is not due to more than one inch of shortening.
6. When the conditions attending treatment prevent better results than those obtained.

The doctrines herein set forth have been almost universally accepted by surgeons in practice, and to a certain extent have been recognized by Courts in medicolegal procedures.

It is to be borne in mind that, in the opinion of most surgeons, "satisfactory result" is a very flexible term, applicable to widely varying conditions, while on the other hand, in every department of surgery, the exaction is for the nearest possible restoration of normal relation and function.

Bloodgood, of Baltimore, in a personal letter says: "Quite frequently with some shortening, due to overlapping or bending, patients are able to walk without special difficulty. I would call this a satisfactory result," and adds, "It is remarkable how good function may exist with a great deal of shortening, provided that axial relations are maintained."

Harry M. Sherman, of San Francisco, believes "the term 'satisfactory result' is capable of two interpretations; one for non-operative, the other for operative treatment," intimating that anatomical adjustment is more probable following the latter method.

My own feeling is that higher standards in fracture treatment should be maintained with a stricter compliance with anatomical requirements. *Nor do I fear, that in departing from traditions, we shall tread upon dangerous ground from the medicolegal standpoint.*

Since Stephen Smith set the pace, the science of radiography has unfolded many secrets affecting the status of fractures at all stages, and it is apparent that end-results which in former days did not challenge adverse criticism on the part of the patient, his friends or later professional attendants, are capable to-day of being shown to be, from the anatomical standpoint, faulty in the extreme.

Whenever the X-ray as an official aid is accessible, it has become an indispensable factor, and the documentary evidence from this source is valuable through every phase of fracture treatment.

With a large experience extending over a period of twenty-five years, I am free to confess, that without the aid of radiography, I am unable to determine with any degree of accuracy the status of many fractures at any time during the progress of repair. This is particularly true of fractures of the femur where fragments are deeply imbedded in muscular tissue, by which outlines are obscured and prominences are impossible of correct definition.

In fracture treatment the surgeon is confronted by three exactions: First, the re-establishment of normal relations (interlocking of fragments); second, maintenance of perfect alignment; third, avoidance of rotation. And it may be added that failure to meet any of these conditions upsets one's calculations as regards the other two.

Very many thigh fractures can be treated ideally under conservative methods. It is obvious that before operation is

to be considered, repeated and conscientious efforts at adjustment and permanent fixation must be made. Just as obviously, conditions attending certain fractures render them practically incorrigible from the standpoint of conservative treatment.

Von Bergmann refers to the accident statistics of Haenel as follows: of 121 fractures of the femur only 39 recovered fully. In 75 the injury was permanent with average loss of earning capacity of 28 per cent.

Fractures of the upper third of the femur are notably obdurate. Many years ago Erichsen stated that in fractures of the upper third of the femur results were invariably unsatisfactory.

In 1890 Allis, at the close of an exhaustive treatise upon "Fractures of the Upper Third of the Femur," makes this significant and manifestly too sweeping statement: "The conversion of a simple into a compound fracture offers the only means of accurate diagnosis, and the only method of rational treatment. Patients and surgeons who stop short of this must compromise with best results."

By the action of certain muscles the upper fragment is rotated outward and drawn upward, while other muscles acting upon the lower fragment separate it widely and assure overriding, rotation and deformity.

My own experience with fractures of the *middle third*, verified by repeated X-ray evidence, has convinced me that ideal adjustment is likewise difficult if not impracticable. Especially is this true of transverse fractures at this point. In several instances of this sort I have made repeated and conscientious efforts at securing apposition, and each time the radiogram through anteroposterior and transverse planes has shown wide separation and overriding.

I wish to emphasize that shortening to an appreciable degree in transverse fractures of the femur means invariably overlapping, a condition which my own standards do not tolerate; and further, that the nearest possible approach to anatomical reposition and correct alignment should be recognized as not beyond the requirements.

During the past two years I have treated conservatively four thigh fractures with the following results: one was positively intolerable because of overriding; two were imperfect but in the ordinary sense satisfactory; one was ideal.

Another consideration is of paramount importance. With overlapping, union is effected with far greater difficulty and at the expense of double the time required when anatomical replacement has been secured.

In my opinion, a very large percentage of all cases of delayed or non-union can be attributed to faulty adjustment.

It is true that untoward results will be manifest less often at the hands of men of supreme intelligence, men who are trained in the use of appliances and methods such as those of Bardenhauer.

I have gone over the volume on fractures by this distinguished author aided by the splendid illustrations which it contains, and I am strongly of the opinion that few patients would submit to confinement in a fixed position during a period of weeks or months.

Furthermore the matter of adjusting multiple traction appliances, exerting force in from two to six different directions simultaneously would involve the average surgeon in overwhelming difficulties.

Were it a fact that operations for the relief of impossible conditions, such as loss of function, persistent pain, delayed or vicious union were easily capable of correction by late operation, any argument for so bold a procedure as an initial operation would have less weight.

Long experience in dealing with this particular lesion, and frequent opportunities of inspecting and correcting unfortunate results, has led me to two conclusions:

1. That the so-called "tolerable" or "satisfactory" results are too often either intolerable or unsatisfactory; overriding of fragments, shortening sufficient to entail permanent limp, angularity and rotation are not rarities in surgical experiences.

Of 92 surgeons appealed to, 69 consider shortening per-

missible to the extent of one inch or more; while 19 limit the shortening to  $\frac{3}{4}$  of an inch and only 4 to  $\frac{1}{2}$  inch.

Appreciable overriding is considered permissible by 75; not permissible by 17.

These opinions, based upon experience, indicate strongly that standards of excellence are not in accord with modern ideals.

Arbuthnot Lane says plainly, "The frequent occurrence of mechanical disability must be known to surgeons generally. . . . It seems little short of ridiculous to read the statements of surgeons, that such condition is a rare sequence of fracture."

2. The operative correction of such conditions, after the lapse of many weeks or months, is to be regarded as one of the most difficult of all undertakings in the realm of bone surgery.

A long train of humiliating failures have attended corrective measures for the relief of unsatisfactory thigh fractures, and it is not strange that such operations are approached with hesitation or positively declined. The first requirement is a long deep incision to expose the deformity and enable the dissection to be carried entirely around it. Bone surfaces, firmly or indifferently united, are to be chiseled apart, following vaguely defined lines of cleavage. Extensive deposits of fibrous or bony material must be removed; often the latter, following the accidental distribution of shredded periosteum, reach far afield and must be torn from their lodgement along fascial planes or within muscle sheaths. The ends of fragments, having lost their original detail, are smooth and conical if not eburnated, and fixation is only possible after removal of more or less of their apices.

If many weeks or months have elapsed, muscles will have permanently contracted to a degree that will require shortening of the bone from  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches. All this is to be followed by drilling fragments and placing of one or two wires, nails, or other appliances. He is a clever operator who can complete such a task in two hours or even more. Exten-

sive unavoidable mutilation of tissues, and further dislodgement of periosteum invite infection, interrupt wound repair and, in a liberal proportion of cases, ensure disaster.

The estimate of the dangers of sepsis in fracture operations in the minds of competent surgeons is as follows: sepsis was considered as either a serious menace or prohibitive by sixty-three; as not a contraindication by twenty-nine.

That these opinions are based very largely upon the statistics of corrective, *i.e.*, late, operations, there is little doubt as less than a score of surgeons appealed to were able to report initial operations while practically all have dealt with late conditions. Only 22 out of 92 conceded the propriety of initial operations and several of these have had no personal experience along this line.

Carlton P. Flint, of New York, writes that from September, 1906, to October, 1907, he personally inspected 834 breaks at the Roosevelt Hospital. There were 53 operative cases, of which 29 were undertaken after delay for corrective purposes. In something over two hundred fracture operations sepsis was a complication in but four. He believes in early operation where the following conditions prevail, *viz.*, all breaks either near the upper or lower ends or at the middle of shaft with great displacement or where efforts at replacement are futile.

In his excellent work on "Operative Treatment of Fractures," Arbuthnot Lane of London says, "In looking through text-books I find any number of reasons given for non-union of broken bones, the vast majority of which are, in my opinion, utterly without foundation. I have never seen one instance in which union would not have resulted if efficient operative measures had been adopted."

In *Progressive Medicine*, December, 1907, Bloodgood refers at length to fracture work as conducted in Vienna. Ranzi reports that of fifty cases operated in Von Eiselberg's Clinic only three or 6 per cent. were for fresh fracture. He emphasizes the dangers of sepsis, inclines to conservatism and contents himself with good functional results.



Bloodgood's comment is suggestive. "In my opinion the argument against immediate operation is not the risk of infection but that radical measures are not absolutely necessary."

The materials heretofore used and at the present time widely in vogue for the purposes of fixation in fracture surgery are, to my mind, manifestly open to adverse criticism. All text-books with which I am familiar suggest, for this purpose, the use of chromic gut, kangaroo tendon, wire, nails, screws, plates, ferrules, or some form of complex apparatus such as the clamp of Parkhill.

I have long since recognized serious objections to wire or any similar material, for two reasons: First, lack of stability. After a careful adjustment of wire or tendon, it will be found that the slightest movement of the distal fragment will loosen the suture to such a degree as to admit of displacement. But the more glaring, and to my mind the fatal defect of the suture lies in the difficulty of its application. After having secured approximate replacement, the fragments must be again widely separated to admit of the introduction of the suture, first through a drill hole in one fragment from without inwards; thence through the medullary canal of the second fragment to complete the loop. This entails much loss of time and an added measure of traumatism to soft parts sufficient to ensure, in many cases, complications through infection. Furthermore wire is prone to break when twisted tightly.

In transverse fractures the application of the screw or nail is irrational and inefficient. The appropriateness of either in oblique fractures will be shown further on. Numerous authorities, notably Edw. Martin of Philadelphia, have written enthusiastically of the value of the screw and plate. To this I raise no positive objection further than it is difficult of accurate application and entails a somewhat complex technic.

Ferrules have practically been abandoned, probably because of interference with bone nutrition at point of contact. Flint states that he has satisfactorily used a bone cylinder to be so placed within the medullary cavities of each frag-



FIG. 2.



Traction apparatus for treatment of fracture of the shaft of the femur.



ment as to prevent displacement. The contrivance is certainly ingenious but when it is considered that the bone peg must be a recent specimen in order to secure ultimate absorption, that it must be of proper diameter and that its adjustment involves a complex procedure, it will probably not appeal to most surgeons.

The principle of the clamp involving protracted exposure to infection through metal cylinders, reaching from the bony fragments through the skin into the outer world, to be engaged in a horizontal bar has been elaborately set forth by Lambotte of Brussels. The apparatus, for obvious reasons, does not appeal to me. It seems to me cumbersome and awkward in the extreme and, entirely aside from the evident menace of sepsis, which I associate with it, I feel confident that the steel staple is a far simpler appliance, and will ultimately supplant it.

W. Arbuthnot Lane of London has repeatedly called attention to the value of the steel staple as a substitute for other fixation material wherever it is applicable. He employs a modification of the staple as devised by Dr. A. Jacoel. (See Fig. 1.)

Lambotte also has employed staples of slightly different type, with three or four legs which will probably be found valuable in comminuted fractures, particularly of the epiphysis.

Rixford reports employment of staples six times on five patients and Sherman four times without an infection. I have used staples in one and wire in five cases. Infection in one of the latter ended in a barely tolerable result.

In dealing with the technic of operative treatment of simple fractures of the femur, I have emphasized the necessity of simpler methods and more efficient fixation. A distinct advantage lies in making provision for systematic mechanical traction which will ensure reposition of fragments without undue violence to soft tissues after exposure of the parts.

The apparatus used at the University Hospital is illustrated in Fig. 2. Its details were worked out and exemplified by Dr. Harry M. Sherman and those who have had the oppor-

tunity of observing it in use regard it as indispensable. This is but the new application of an old principle and has possibly been used by others, though I find no allusion to it in the literature.

A skein of heavy woolen yarn is passed over each leg to serve as a medium for perineal traction. To each of these is attached a cord whose distal ends are tied to a ring in the end wall of the room. Another similar skein is applied to the ankle of the affected limb with a clove hitch. To this is attached a small set of pulleys which, in turn, are anchored to the wall at the foot of the operating table and the pulley rope is intrusted to an assistant.

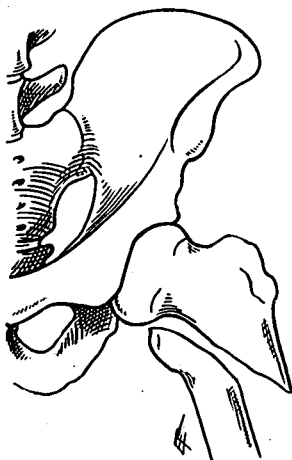
Under the most careful aseptic precautions a comparatively small incision will suffice to uncover one or both ends of fragments. At this point the value of the traction apparatus is clearly apparent. The fracture being a recent one, no elaborate dissection is requisite. Having identified the line of fracture, traction by the pulley exerted upon the overlapping bones serves to bring the lower fragment slowly downward until it is capable, by external pressure upon both fragments, of being placed in exact axial relation. If the fracture be transverse or nearly so, slight relaxation of tension will serve to interlock the fragments. The operation now becomes delightfully simple. With the fragments interlocked, rotation being avoided, a drill hole is sunk in each fragment from  $\frac{1}{2}$  to  $\frac{3}{4}$  of an inch from the fracture line, the interval being determined by the length of the staple to be introduced. The placing of the staple is materially aided by the use of an ordinary carpenter's nail set, each limb of the staple being gently driven into the corresponding drill hole. We now have the fragments firmly united in exact anatomical relation by an unyielding steel splint. If the fracture be oblique or spiral the traction principle is alike applicable. Exact reposition being thus obtained, maintenance of proper relations is secured. In these cases the staple may or may not be found available. If the conditions are such as to throw a doubt upon the efficiency of one or more staples applied at each end of the

FIG. 3a.

FIG. 3.

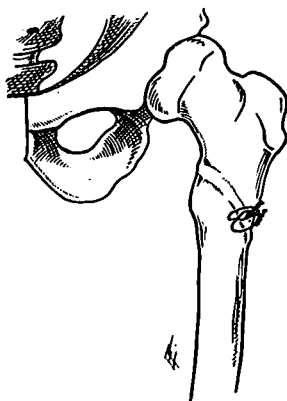
Skiagram tracing, showing original condition and end-result after wiring.

FIG. 4.



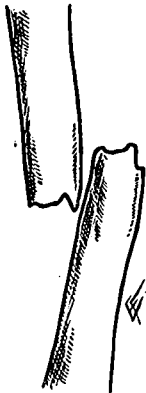
Subtrochanteric fracture of femur with marked displacement. (Tracing from skiagraph.)

FIG. 4A.



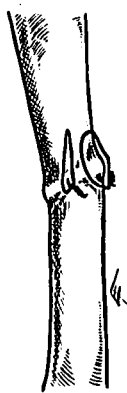
End-result obtained by wiring in case shown in Fig. 4. (Tracing from skiagraph.)

FIG. 5.



Before operation. Lateral view. Pseudarthrosis, with crippling deformity.

FIG. 5A.

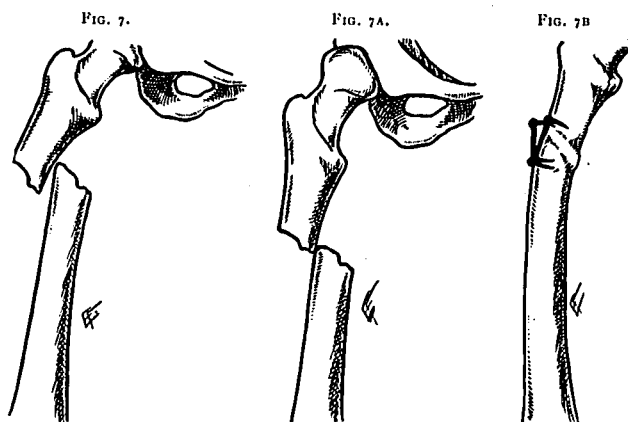


After operation.

FIG. 6.



Showing end-result in a recent fracture treated with wire and staple. (Tracing from skiagraph.)



Figures 7, 7A and 7B, showing original condition, status after several efforts at adjustment and end-result after application of staple, with slight lateral bowing. (Tracings from skiagraphs.)



**FIG. 8**



**Showing end-result after use of staple in a transverse fracture.**

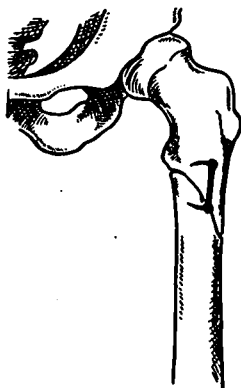
FIG. 9.



FIG. 9A.



FIG. 10.



Figures 9 and 9A, showing overlapping associated with non-union, at the end of sixteen weeks. Good union secured in five weeks, after use of staple, without shortening. (Tracing from skingraph.)

Showing oblique subtrochanteric fracture ten days after use of staple.

fracture line, a single steel screw of the proper length and calibre may be used as a substitute. By it the permanency of adjustment may be absolutely assured.

Closure of the wound merits a passing word. A continuous catgut suture should be applied from the deepest layer of soft tissues outward so as effectually to obliterate the dead space overlying the fracture line and staple.

Drainage, in cases where there is extensive oozing, is probably a safeguard, but in the average case I believe it is to be omitted on the ground that it affords an avenue of ingress for infection.

The wound, having been carefully protected by a gauze dressing and before pulley traction is wholly released, a plaster of Paris spica is applied from the lower leg to the waist line.

To avoid slight curvature at point of fracture as has occurred in several instances, it is best to employ permanent traction apparatus for a period of a week or ten days succeeding operation.

#### CONCLUSIONS.

1. The term "satisfactory result" is too elastic and does not conform to any standard.
2. The two plane radiogram when available affords the most reliable diagnosis, and determines the plan of treatment.
3. The possibility of infection is not a prohibitive menace.
4. Operative wounds are less susceptible to infection in initiative than in late corrective procedures.
5. Approximate anatomical reposition is essential to quick repair and ideal result.
6. In oblique fractures slight overriding is permissible.
7. In transverse fractures appreciable shortening is due to overlapping of fragments, and is incompatible with good surgery.
8. Mechanical traction during operation is indispensable.
9. Steel staples (or screws in oblique fractures), because of ease of adjustment and efficiency, have proven superior to other methods of fixation.